FORM PTO-1390 (Modified) (REV 11-98) U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY'S DOCKET NUMBER: **VOI0219**

U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR): 09/600941

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/EP99/00373	**21 January 1999 (21/01/99)**	**26 January 1998 (26/01/98)**

TITLE OF INVENTION
HYDRODYNAMIC COUPLING

APPLICANT(S) FOR DO/EO/US
HOFFELD, Harald et al.

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This is an express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
4. ☒ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. ☒ A copy of the International Application as filed (35 U.S.C. 371 (c) (2))
   a. ☒ is transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☐ has been transmitted by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☒ A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7. ☒ A copy of the International Search Report (PCT/ISA/210).
8. ☐ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371 (c)(3))
   a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☐ have been transmitted by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ☐ have not been made and will not be made.
9. ☐ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
10. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371 (c)(4)).
11. ☒ A copy of the International Preliminary Examination Report (PCT/IPEA/409).
12. ☒ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371 (c)(5)).

Items 13 to 20 below concern document(s) or information included:

13. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
14. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
15. ☒ A **FIRST** preliminary amendment.
16. ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
17. ☐ A substitute specification.
18. ☐ A change of power of attorney and/or address letter.
19. ☒ Certificate of Mailing by Express Mail
20. ☒ Other items or information:

Check No. 048180 in the amoun of $840.00

U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR)	INTERNATIONAL APPLICATION NO	ATTORNEY'S DOCKET NUMBER
09/600941	PCT/EP99/00373	VOI0219

21. The following fees are submitted:.

BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) :

		CALCULATIONS PTO USE ONLY
☐	Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2) paid to USPTO and International Search Report not prepared by the EPO or JPO **$970.00**	
☒	International preliminary examination fee (37 CFR 1.482) not paid to USPTO but Internation Search Report prepared by the EPO or JPO **$840.00**	
☐	International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO **$690.00**	
☐	International preliminary examination fee paid to USPTO (37 CFR 1.482) but all claims did not satisfy provisions of PCT Article 33(1)-(4) **$670.00**	
☐	International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(1)-(4) **$96.00**	
	ENTER APPROPRIATE BASIC FEE AMOUNT =	**$840.00**
	Surcharge of **$130.00** for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (e)).	**$0.00**

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	15 - 20 =	0	x $18.00	**$0.00**	
Independent claims	1 - 3 =	0	x $78.00	**$0.00**	
Multiple Dependent Claims **(check if applicable).**			☐	**$0.00**	
	TOTAL OF ABOVE CALCULATIONS =			**$840.00**	
	Reduction of 1/2 for filing by small entity, if applicable. Verified Small Entity Statement must also be filed (Note 37 CFR 1.9, 1.27, 1.28) **(check if applicable).** ☐			**$0.00**	
	SUBTOTAL =			**$840.00**	
	Processing fee of **$130.00** for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (f)). +			**$0.00**	
	TOTAL NATIONAL FEE =			**$840.00**	
	Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31) **(check if applicable).** ☐			**$0.00**	
	TOTAL FEES ENCLOSED =			**$840.00**	
				Amount to be: refunded	$
				charged	$

☒ A check in the amount of **$840.00** to cover the above fees is enclosed.

☐ Please charge my Deposit Account No. in the amount of to cover the above fees.
A duplicate copy of this sheet is enclosed.

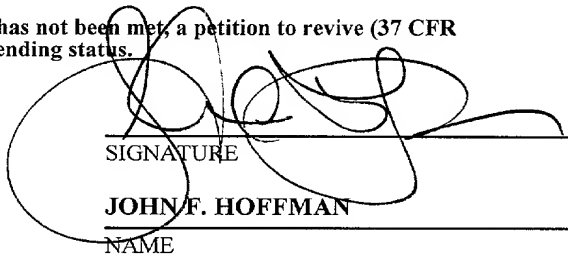
☒ The Commissioner is hereby authorized to charge any fees which may be required, or credit any overpayment to Deposit Account No. **02-0385** A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

John F. Hoffman
BAKER & DANIELS
111 East Wayne Street, Suite 800
Fort Wayne, Indiana 46802

TX: (219) 424-8000
FAX: (219) 460-1700



SIGNATURE

JOHN F. HOFFMAN
NAME

26,280
REGISTRATION NUMBER

July 24, 2000
DATE

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re the Application of	)	Group:
Harald Hoffeld et al.	)	
Serial No.	)	Examiner:
Filed:	)	
Title: HYDRODYNAMIC COUPLING	)	

PRELIMINARY AMENDMENT DELETING MULTIPLE DEPENDENT CLAIMS

Assistant Commissioner of Patents
Washington, DC 20231

Sir:

Prior to calculating the filing fee, please enter the following amendments to the application.

IN THE CLAIMS

In claim 5, line 1, delete "one of the claims 1 to 4" and substitute therefor --claim 1--.

In claim 6, line 1, delete "one of the claims 1 to 5" and substitute therefor --claim 1--.

In claim 7, line 1, delete "one of the claims 1 to 6" and substitute therefor --claim 1--.

In claim 10, line 1, delete "one of the claims 7 to 9" and substitute therefor --claim 7--.

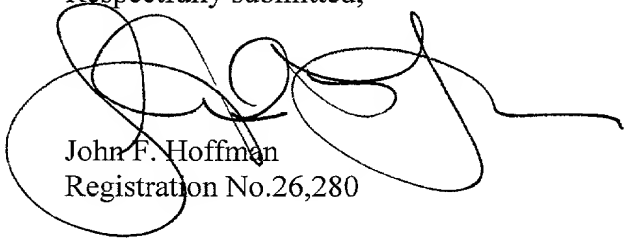
In claim 11, line 1, delete "one of the claims 1 to 10" and substitute therefor --claim 1--.

In claim 12, line 1, delete "one of the claims 1 to 10" and substitute therefor --claim 1--.

In claim 14, line 1, delete "one of the claims 1 to 12" and substitute therefor --claim 1--.

In claim 15, line 1, delete "one of the claims 1 to 12" and substitute therefor --claim 1--.

Respectfully submitted,



John F. Hoffman
Registration No.26,280

Attorney for Applicant

JFH/pmp/137575.1

BAKER & DANIELS
111 East Wayne Street, Suite 800
Fort Wayne, IN 46802

Date: July 24, 2000

Hydrodynamic Coupling

The invention relates to a hydrodynamic coupling, in particular with the characteristics of the generic concept of claim 1.

Hydrodynamic couplings are known for many application cases in many embodiments. An application case of a hydrodynamic coupling in a turbo compound system is disclosed in the reference DE 92 02 578.1. This coupling is connected to the lubricating oil circulation of the internal combustion engine and uses this oil as an operating medium and coolant. From this document it is known that when using motor oil as an operating medium in hydrodynamic couplings, complications can result by impurities in the oil settling on the inside of the circumferential wall of the coupling, which can lead to a block of the coupling and to a loss of its capacity to offset the torque and rotational speed fluctuations. Since the entire coupling rotates, it acts like a centrifugal oil filter. Pump blades and turbine blades of the coupling are manufactured with a high form precision and surface quality, so that between the pump wheel and the turbine wheel, a circulatory flow finds optimal flow-through ratios and thus leads to a high degree of efficiency of the coupling. Because of the design of the blade mounting and the flow circulating between the turbine wheel and pump wheel, the danger of a deposition of solids on the blade mounting itself is generally negligible. Problems are caused by the condition, however, when the motor oil used as an operating medium leaves the operating chamber formed from the blades and thus no longer is found in the circular and rinsing flow between the blades, but instead is only exposed to the centrifugal force generated by the rotation of the coupling. Impurities in the oil are then centrifuged on account of their higher specific gravity, against the circumferential wall of the coupling where a danger of deposition certainly then occurs, when the inside of the circumferential has unevenness in the form of projections, recesses or edges or an insufficient surface quality. In case the primary side of the coupling gets caught on the secondary side due to deposits, then a rigid connection between the primary side and the secondary side results from this, such that during rotary oscillations of the crankshaft of the internal combustion engine, a damage can result either to the coupling or to the drive parts operating together with it. Furthermore, solid deposits in the coupling can also

harm the flow in the coupling, which can lead to an increase of the operating temperature and as a result to a damage of the coupling. Another essential problem is the unbalanced mass generated by the deposit, which causes bending vibrations. If the primary side of the coupling touches the secondary side due to deposits, then an additional transmission of torque results from this. In order to avoid this disadvantageous effect, it is proposed in this document that hydrodynamic couplings contain a pump wheel and a turbine wheel, which are connected with a shaft and where the individual blade wheels each form a half-toroidal ring that face each other, have a blade holder and thus form a toroid-shaped operating chamber, and where one of these blade wheels has a housing that is affixed to its radial outer edge, extends radially to the inside and surrounds the rear side of the other wheel, in order to provide the inner side of the housing that faces the rear side of the other wheel with a coating that is friction-reducing and/or inhibitive to solid depositions. This coating generates a very smooth surface, which however, only minimizes the possibility for the depositions, but does not eliminate them. Furthermore, the application of a coating means an increased expense and damages in the coating reduce the success and create additional deposit surfaces.

The purpose of the invention is therefore to further develop a hydrodynamic coupling for use in drive systems which have an operating medium flowing through them in such a way that the problem of the depositions is ruled out to the maximum possible extent. The solution according to the invention should in the process be characterized by as small as possible expense for construction and manufacturing technology.

The solution according to the invention is characterized by the characteristics of claim 1. Advantageous embodiments are described in the subordinate claims.

The hydrodynamic coupling, which contains a pump blade wheel and a turbine blade wheel, each forming at least one toroidal operating space with each other and can be filled with an operating medium, has a housing that preferably operates together in rotation with it, which contains the pump wheel at least partially and the turbine wheel

also at least partially as observed in the axial direction and forms an intermediate space at least with the pump wheel and the turbine wheel. According to the invention it is provided that in order to connect operating space and intermediate space in the pump wheel, at least one opening is provided, which forms a channel through the pump wheel, which extends from the inner surface of the mounted blade part of the pump wheel to the outer circumference of the pump wheel and is oriented in such a way that the position can be described via at least one directional component, which is placed in the toroidal operating space tangentially on the contour of the operating and/or flow circulation occurring between the two blade wheels. The distance between the outer circumference of the pump wheel and the housing in the radial direction is designed in such a way that a rinsing current forms in the intermediate space and the operating medium is not washed down because of the centrifugal force. In other words, there is a spatially close arrangement. The concrete dimensioning, however, is a function of a series of factors, among other things, the rotational speed of the pump wheel.

The solution according to the invention makes it possible that in addition to the flow circulation in the toroidal operating space, for the purpose of force transfer, a partial flow of operating medium is branched off, which gets into the intermediate space directly and makes possible a rinsing effect for the deposits collected there or on the housing.

Preferably, the connection channel, i.e. the opening on the pump wheel, is constructed so that it is oriented tangentially in the direction of the circulation contour, i.e. in the direction of the flow that is becoming adjusted in the operating space during operation and is oriented in the flow direction. This makes it possible to generate the partial flow with the smallest possible resistances and flow speed losses and thus to obtain and optimal rinsing effect.

Preferably, a majority of connection channels, i.e. openings in the pump wheel, are provided. These can either be arranged either

1. on a common hypothetical theoretical circumferential line or, however,
2. on several different hypothetical circumferential lines

on the pump wheel. Understood as the circumferential lines are the hypothetical theoretical lines on the outer circumference of the pump wheel, which run parallel to the hypothetical center plane between the pump blade wheel and the turbine blade wheel when the coupling is installed. There is the possibility to make the arrangement alternately on different circumferential lines.

The connection lines or openings on the pump blade wheel can, furthermore, be arranged on a circumferential line or several circumferential lines at

1. constant intervals or
2. different intervals between two adjacent openings.

The selection of the number and the arrangement on the different circumferential lines is at the discretion of the professional.

For the embodiment of the cross-section of the connection channels or openings, many possibilities are conceivable. For example, they can have a circular cross-section, oval embodiments or embodiments with cross-sections in the form of oblong holes.

The embodiment of the connection channel of the toroidal operating space at the outer circumference of the pump blade wheel can be made in many designs. Preferably, an embodiment that is directly oriented, in particular, tangential to the circulation contour in the operating space is provided. However, there is also the theoretical possibility to perform slight changes to a progression of this type. However, what leads to considerable damage of the partial flow, and thus to the impairment of its function, is avoided. Slight deviations from a straight-line progression in the connection channel are conceivable, however.

Furthermore, the connection channel between the toroidal operating space and the outer circumference of the pump wheel can be designed with

1. constant cross-section
2. variable cross-sections.

Cross-section changes to affect the partial flow are preferably made to gradually increase the flow speed.

The individual possibilities with regard to the cross-sectional embodiments of the connection channels or openings, whose arrangement on one or even many different circumferential lines on the pump wheel and/or the embodiment of the progression of the connection channel or the opening on the pump wheel from the toroidal operating space up to the outer circumference of the pump wheel can be combined in any desired manner with each other according to the intended effect. The concrete selection is done in this process preferably according the conditions of the usage case, especially the operating medium used.

The solution according to the invention can be used for many hydrodynamic couplings with different applied purposes. Embodiments are conceivable in which the housing of the hydrodynamic coupling is coupled either at least indirectly rotationally fixed with the primary blade wheel, i.e. the pump blade wheel or even the secondary blade wheel, i.e. the turbine blade wheel, i.e. the housing rotates in the operating condition, i.e. in hydrodynamic coupling of the pump wheel, together with the turbine wheel. This application case represents in the process a preferred application case, since in this arrangement a contact of one of the two blade wheels with a deposition on the housing is most likely to lead to damage, and furthermore, the occurrence of an imbalance is also avoided.

A preferred application of the solution according to the invention is made in a turbo compound system, in which the operating medium of the hydrodynamic coupling is made from the operating medium or oil of the internal combustion engine. Directly in these systems, problems often occur because of the deposits, which result from the suspended matter centrifuged out because of the fast rotating machine parts that the operating medium flows through.

The solution according to the invention for creating an operating circulation between pump blade wheel and turbine blade wheel with a partial flow that is used to rinse the intermediate space between the blade wheels and the housing, makes possible a solution to the problems of eliminating the deposits in the intermediate space between the housing and the outer circumferential surfaces of the individual blade wheels, which is simple and cost-effective in terms of manufacturing technology,

The solution according to the invention is explained in the following using the Figures. The following is depicted:

Fig. 1 shows, using an embodiment example in a turbocompound system, the embodiment according to the invention and operating method of the hydrodynamic coupling;

Fig. 2 shows possible cross-sections of the connection channel between the operating space and the outer circumference of the pump blade wheel;

Fig. 2b shows an embodiment example for a progression of the connection channel between the toroidal operating space and the outer circumference of the pump blade wheel with a varying cross-section over the length of the connection channel.

Fig. 1 shows, using the embodiment example in the form of a hydrodynamic coupling 1 in a turbo compound system 2, the solution according to the invention. The

hydrodynamic coupling 1 includes a primary wheel 3, which is also characterized as a pump wheel, and a secondary wheel 4, which is characterized as a turbine wheel. Pump and turbine wheel 3 or 4 together form at least one toroidal operating space 5, which can be filled with an operating fluid, for example, with oil. The pump wheel 3 is driven by a gear arranged on a shaft, not shown here, of a drive turbine, not shown here. For this purpose, the gear meshes with a gear 6 coupled so that it is rotationally fixed to the pump wheel 3.

The turbine wheel 4 is arranged on a drive shaft 7 of the hydrodynamic coupling 1. In the embodiment example shown, the turbine wheel 4 is coupled to the drive shaft 7 so that it is rotationally fixed using non-positive and/or positive connections in the form of screw connections, here represented by the screw connections 8 and 9.

The pump wheel 3 is set in bearings at least indirectly on the driven shaft 7 via a bearing arrangement 10, which preferably contains two ball bearings 11 and 12. The ball bearings of the bearing arrangement 10 are designed as angular ball bearings. These make it possible to receive combined stresses, i.e. radial and axial forces, better than deep groove ball bearings. The pump wheel 3 is supported via the outer rings 13 or 14 of the angular ball bearings 11 or 12 and the inner rings 15 or 16 directly on the driven shaft 7. In order to create the torque reception on the pump wheel and in order to pass it on via the operating mechanism to the turbine wheel 4, the rotation is done by the pump wheel 3 and the outer rings 13 or 14 of the angular ball bearings 11 or 12 at the same rotational speed. Between the outer rings 13 or 14 and the pump wheel 3, press fits are provided for this purpose. The same applies for the support of the gear 6 via an additional bearing arrangement 17 on the driven shaft 7.

The supply of oil to the operating space 5 is done in the case represented directly via the driven shaft 7. For this purpose, the driven shaft 7 has a drill hole 18, which is preferably arranged coaxially to the symmetry axle A of the driven shaft 7. This drill hole extends from the primary side up to a certain extent to the plane E arranged through

the middle vertical line through the toroidal operating space. From this central hole 18, additional distribution holes 19 or 20 branch off, which extend from the central bore hole 18 to the outer circumference 21 of the driven shaft 7 in the radial direction. Via the central bore hole 18 and the distribution bore holes 19 and 20, the operating fluid is conducted into the toroidal operating space 5. At the same time, a branching off of an operating medium current occurs for the bearing arrangement 10. For this purpose, a disc 22 is arranged between the pump wheel 3 and the turbine wheel 4, which has a beveled inner contour 23, which functions as a peeling edge for the operating medium. The beveled inner contour 23 runs in the process from a supply space 24 to the outer rings 13 or 14 of the angular ball bearings 11 or 12 of the bearing arrangement 10. The two angular ball bearings 11 or 12 are thus completely flooded. According to the design of the disc 22, the size of the operating medium current that is branched off can be affected. Thus only a central operating medium supply and thus also a lubricant supply is necessary. For a corresponding design, there is also the possibility here for additionally supplying the bearing 17, which functions for the support of the gear 6 on the driven shaft 7.

The hydrodynamic coupling 1 is enclosed by a bell-shaped housing 26. This housing is preferably designed as a deep-drawn part and is via various connection possibilities is preferably mounted indirectly to the gear. However, there is also the theoretical possibility, but here not depicted in detail, for coupling the housing either rotationally fixed to the pump wheel 3 or the to the turbine wheel 4, such that however, an intermediate space 27 is always formed between the pump wheel 3 and the housing 26. Because of the coupling between the housing 26 and the gear 6, the housing rotates together in the operation of the coupling or the drive of the pump wheel 3.

During the operation of the coupling, operating medium gets out of the toroidal operating space 5 into the intermediate space 27. The operating medium is thus no longer exposed to the circular and rinsing current between the blade mounting of the two blade wheels, pump wheel and turbine wheel, but instead is only exposed to the centrifugal

force generated by the rotation of the coupling. Impurities in the operating medium are then centrifuged because of their high specific gravity against the inner wall 30 of the housing 26, where a danger of deposition at least always occurs, if on this inner side 30, unevennesses are provided in the form of projections, recesses or edges and/or it has an insufficient surface quality. This can lead to the contact of the secondary wheel 4 to the housing 26, such that a rigid coupling can result between the primary side and the secondary side. Furthermore, locational deposits can cause the formation on the surrounding housing of unbalanced masses, which result in bending vibrations. To solve this problem, openings 31 are provided in the pump wheel 3, for example, in the form of a connection channel between the blade base and the outer circumference of the blade wheel, which is constructed in such a way that its bearing can be described by at least one directional component in the flow direction in the operating state between pump wheel and turbine wheel as well as essentially tangentially to the contour of the flow progression that becomes set between the pump wheel and the turbine wheel, which allows the formation of a partial current from the operating space 5 to the intermediate space 27. The openings 31 extend in the process preferably from the inner surface of the blade mounted part, in particular from the blade base 32, to the outer circumference 33 of the pump wheel 3. The openings 31 are oriented in the process in such a way that at least one directional component is present to describe the position, which is oriented essentially tangentially to the contour of the operating mechanism circulation in the toroidal operating space 5 as seen in the operating condition. The direction of the tangential component, which can be used to describe the orientation of the opening 31, is thus always oriented in the direction of the current in the circulation in the toroidal operating space 5.

Preferably many openings are provided in the circumferential direction of the hydrodynamic coupling, in particular of the pump wheel 3, where they are arranged preferably at the same height and on a theoretical, hypothetical circumferential line UL on the circumference 33 of the pump wheel 3. The distances between the individual openings 31 are preferably selected to be constant.

The opening 31 has a constant cross-section in the case depicted from the blade base up to the outer circumference 33 of the pump wheel 3 and is designed in the form of a through-put bore. Every other possible cross-section is also conceivable. Furthermore, the possibility not shown in detail here, for providing the opening 31 with a varying cross-section over its extension from the blade wheel inner surface 31 of the pump wheel 3 to the outer circumference of the pump wheel 3 in order to affect the partial current flowing over it. Examples for the varying cross-sections are reproduced in Fig. 2a and examples for the possible cross-section changes are reproduced in Fig. 2b.

Figure 2a shows possible cross-sections of the openings 31. The variation provided according to Fig. 2a 1 in the form of through-put bore holes with circular cross-sections 31a with a diameter D represents a preferred variation that is simplest to create in manufacturing. Also conceivable, however, is a design according to Fig. 2a 2 in the form of a longitudinal hole 31b. The cross-sections depicted are thus cross-sections as result when the section according to section I-I in Fig. 1 is made, i.e. made in a plane, which can be defined by the outer limits of the openings and is perpendicular to the running direction of the opening.

Fig. 2b shows an embodiment with a cross-section that is constantly narrowing to the outer circumference 33 of the pump wheel 3.

The embodiments according to Fig. 1 and 2 represent only examples of the solution according to the invention. The concrete design or arrangement is done according to the requirements of the individual case and is at the discretion of the professional.

Claims

1. Hydrodynamic coupling (1),

1.1 with a pump blade wheel (3) and a turbine blade wheel (4), each forming at least one toroidal operating space (5) with each other and can be filled with an operating medium,

1.2 with a housing (26) that contains the pump blade wheel (3) at least partially in the axial direction;

1.3 the housing (26) forms an intermediate space (27) at least with the pump wheel (3); characterized by the following characteristics:

1.4 at least one connection channel (31) is provided in the pump blade wheel (3) between the toroidal operating space (5) and the intermediate space (27);

1.5 the connection channel (31) is designed and oriented in such a way to create a partial flow for rinsing the intermediate space, that at least one directional component is oriented in the flow direction in the operating state of the hydrodynamic coupling (1) between the pump and the turbine blade wheel (3, 4) as well as essentially tangentially to the circulation contour of the flow circulation that becomes set in the operating state between the pump blade wheel (3) and the turbine blade wheel (4).

2. Hydrodynamic coupling according to claim 1, characterized in that the housing (26) surrounds the coupling (1) in the operating state.

3. Hydrodynamic coupling according to claim 2, characterized in that the housing (26) is coupled at least indirectly to the pump wheel (3).

4. Hydrodynamic coupling according to claim 2, characterized in that the housing (26) is coupled at least indirectly to the turbine blade wheel (4).

5. Hydrodynamic coupling according to one of the claims 1 to 4, characterized in that the connection channel is oriented between the toroidal operating space (5) and the intermediate space (27) tangentially in the direction to the circulation contour of the flow circulation that becomes set between the pump blade wheel (3) and turbine blade wheel (4)

6. Hydrodynamic coupling according to one of the claims 1 to 5, characterized in that the connection channel (31) has a straight-line progression free of directional changes.

7. Hydrodynamic coupling according to one of the claims 1 to 6, characterized in that many connection channels (31) are provided.

8. Hydrodynamic coupling according to claim 7, characterized in that the connection channels (31) are arranged on a theoretical, hypothetical circumferential line (UL) of the pump blade wheel (3), which are arranged parallel to a central plane, which is arranged between the pump (3) – and the turbine blade wheel (4) in the installed condition.

9. Hydrodynamic coupling according to claim 7, characterized in that the connection channels (31) are arranged on a theoretical, hypothetical circumferential lines of the pump blade wheel (3), which run parallel to a central plane between the pump blade wheel (3) and the turbine blade wheel (4) in the installed condition.

10. Hydrodynamic coupling according to one of the claims 7 to 9, characterized in that the distance between two adjacent connection channels (31) is constant.

11. Hydrodynamic coupling according to one of the claims 1 to 10, characterized in that the cross-section of the connection channel (31) is designed to be

constant over its extension from the inner circumference (32) of the pump wheel (3) to the outer circumference (33).

12. Hydrodynamic coupling according to one of the claims 1 to 10, characterized in that the connection channel (31) has at least one cross-sectional change over its extension from the inner circumference (32) of the pump wheel (3) to the outer circumference (33).

13. Hydrodynamic coupling according to claim 12, characterized in that the connection channel (31) is designed to taper in the direction of the outer circumference (33) of the hydrodynamic coupling (1).

14. Hydrodynamic coupling according to one of the claims 1 to 12, characterized in that the cross-section of the connection channel (31a) is designed to be circular.

15. Hydrodynamic coupling according to one of the claims 1 to 12, characterized in that the cross-section of the connection channel (31b) is designed to be oval.

#3 C Burt 27 Sept 00

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of
Harald Hoffeld et al.
Serial No.: 09/600,941
Filed: July 24, 2000
Title: HYDRODYNAMIC COUPLING

Group:

Examiner:

ATTENTION: APPLICATION PROCESSING DIVISION
SPECIAL PROCESSING AND CORRESPONDENCE BRANCH

SUBMISSION OF EXECUTED DECLARATION

Assistant Commissioner for Patents
Washington, DC 20231

Sir:

In response to the Notice to File Missing Parts of Application mailed August 14, 2000, enclosed herewith is the signed and dated Declaration in the above-identified application together with a copy of Form PTO/DO/EO/905.

Submitted herewith is a check in the amount of $130.00, to cover the late Declaration surcharge. If the enclosed remittance is insufficient, the Commissioner is authorized to charge payment of the following fees during pendency of this application or credit any overpayment to Deposit Account No. 02-0385 BAKER & DANIELS:

1. Any additional fees required under 37 CFR 1.16.
2. Any patent application processing fees under 37 CFR 1.17
3. Any filing fees under 37 CFR 1.16 for presentation of extra claims

It is submitted that with the filing of the above documents, the application is complete and may be submitted for examination by the Patent and Trademark Office.

Respectfully submitted,

John F. Hoffman
Registration No. 26,280
Attorney for Applicants

JFH/pmp /144634 1

BAKER & DANIELS
111 EAST WAYNE STREET, SUITE 800
FORT WAYNE, IN 46802
TELEPHONE: 219-424-8000
FACSIMILE: 219-460-1700

Enc. Check No. 048899
Declaration
Form PTO/DO/EO/905
Return Postcard

"EXPRESS MAIL" MAILING LABEL NUMBER EL058951852US

DATE OF DEPOSIT September 13, 2000

I HEREBY CERTIFY THAT THIS PAPER OR FEE IS BEING DEPOSITED WITH THE UNITED STATES POSTAL SERVICE "EXPRESS MAIL POST OFFICE TO ADDRESSEE" SERVICE UNDER 37 CFR 1.10 ON ~~THE DATE~~ INDICATED ABOVE AND IS ADDRESSED TO THE COMMISSIONER OF PATENTS AND TRADEMARKS, WASHINGTON, DC 20231.

Patrice Michele Potter
(Typed Name of Person Mailing Paper or Fee)

Patrice Michele Potter
(Signature of Person Mailing Paper or Fee)

09/18/2000 ERIMANDO 00000009 09600941
01 FC:154 130.00 OP

PTO/SB/103 (8-96)
Approved for use through 9/30/98. OMB 0651-0032
Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE

Declaration and Power of Attorney for Patent Application
Erklärung für Patentanmeldungen mit Vollmacht

German Language Declaration

Als nachstehend benannter Erfinder erkläre ich hiermit an Eides Statt:

daß mein Wohnsitz, meine Postanschrift und meine Staatsangehörigkeit den im nachstehenden nach meinem Namen aufgeführten Angaben entsprechen, daß ich nach bestem Wissen der ursprüngliche, erste und alleinige Erfinder (falls nachstehend nur ein Name angegeben ist) oder ein ursprünglicher, erster und Miterfinder (falls nachstehend mehrere Namen aufgeführt sind) des Gegenstandes bin, für den dieser Antrag gestellt wird und für den ein Patent für die Erfindung mit folgendem Titel beantragt wird:

DER

_____

_____

deren Beschreibung hier beigefügt ist, es sei denn (in diesem Falle Zutreffendes bitte ankreuzen), diese Erfindung

☐ wurde angemeldet am _____
unter der US-Anmeldenummer oder unter der Internationalen Anmeldenummer im Rahmen des Vertrags über die Zusammenarbeit auf dem Gebiet des Patentwesens (PCT)
_____ und am
_____ abgeändert (falls zutreffend).

Ich bestätige hiermit, daß ich den Inhalt der oben angegebenen Patentanmeldung, einschließlich der Ansprüche, die eventuell durch einen oben erwähnten Zusatzantrag abgeändert wurde, durchgesehen und verstanden habe.

Ich erkenne meine Pflicht zur Offenbarung jeglicher Informationen an, die zur Prüfung der Patentfähigkeit in Einklang mit Titel 37, Code of Federal Regulations, § 1.56 von Belang sind.

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

HYDRODYNAMIC COUPLING

_____

the specification of which is attached hereto unless the following box is checked:

☒ was filed on January 21, 1999
as United States Application Number or PCT International Application Number
PCT/EP99/00373 and was amended on
_____ (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, § 1.56.

PTO/SB/103 (8-96)
Approved for use through 9/30/98. OMB 0651-0032
Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE

German Language Declaration

Ich beanspruche hiermit ausländische Prioritätsvorteile gemäß Title 35, US-Code, § 119 (a)-(d), bzw. § 365(b) aller unten aufgeführten Auslandsanmeldungen für Patente oder Erfinderurkunden, oder § 365(a) aller PCT internationalen Anmeldungen, welche wenigstens ein Land ausser den Vereinigten Staaten von Amerika benennen, und habe nachstehend durch ankreuzen sämtliche Auslands- anmeldungen für Patente bzw. Erfinderurkunden oder PCT internationale Anmeldungen angegeben, deren Anmeldetag dem der Anmeldung, für welche Priorität beansprucht wird, vorangeht.

I hereby claim foreign priority under Title 35, United States Code, § 119(a)-(d) or § 365(b) of any foreign application(s) for patent or inventor's certificate, or § 365(a) of any PCT International application which designated at least one country other than the United States, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or PCT International application having a filing date before that of the application on which priority is claimed.

Prior Foreign Applications
(Frühere ausländische Anmeldungen)

Priority Not Claimed
Priorität nicht beansprucht

(Number) (Nummer)	(Country) (Land)	(Day/Month/Year Filed) (Tag/Monat/Jahr der Anmeldung)	
198 02 524.6	Germany	26 January 1998	☐
			☐

Ich beanspruche hiermit Prioritätsvorteile unter Title 35, US-Code, § 119(e) aller US-Hilfsanmeldungen wie unten aufgezählt.

I hereby claim the benefit under Title 35, United States Code, § 119(e) of any United States provisional application(s)listed below.

(Application No.) (Aktenzeichen)	(Filing Date) (Anmeldetag)

Ich beanspruche hiermit die mir unter Title 35, US-Code, § 120 zustehenden Vorteile aller unten aufgeführten US-Patentanmeldungen bzw. § 365(c) aller PCT internationalen Anmeldungen, welche die Vereinigten Staaten von Amerika benennen, und erkenne, insofern der Gegenstand eines jeden früheren Anspruchs dieser Patentanmeldung nicht in einer US-Patentanmeldung, bzw. PCT internationalen Anmeldung in in einer gemäß dem ersten Absatz von Title 35, US-Code, § 112 vorgeschriebenen Art und Weise offenbart wurde, meine Pflicht zur Offenbarung jeglicher Informationen an, die zur Prüfung der Patentfähigkeit in Einklang mit Title 37, Code of Federal Regulations, § 1.56 von Belang sind und die im Zeitraum zwischen dem Anmeldetag der früheren Patentanmeldung und dem nationalen oder im Rahmen des Vertrags über die Zusammenarbeit auf dem Gebiet des Patentwesen (PCT) gültigen internationalen Anmeldetags bekannt geworden sind.

I hereby claim the benefit under Title 35, United States Code, § 120 of any United States application(s), or § 365(c) of any PCT International application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of Title 35, United States Code, § 112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, § 1.56 which became available between the filing date of the prior application and the national or PCT International filing date of this application.

(Application No.) (Aktenzeichen)	(Filing Date) (Anmeldetag)	(Status) (patented, pending, abandoned) (Status) (patentiert, schwebend, aufgegeben)
PCT/EP99/00373	21 January 1999	Published

Ich erkläre hiermit, daß alle in der vorliegenden Erklärung von mir gemachten Angaben nach bestem Wissen und Gewissen der Wahrheit entsprechen, und ferner daß ich diese eidesstattliche Erklärung in Kenntnis dessen ablege, daß wissentlich und vorsätzlich falsche Angaben oder dergleichen gemäß § 1001, Title 18 des US-Code strafbar sind und mit Geldstrafe und/oder Gefängnis bestraft werden können und daß derartige wissentlich und vorsätzlich falsche Angaben die Rechtswirksamkeit der vorliegenden Patentanmeldung oder eines aufgrund deren erteilten Patentes gefährden können.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

German Language Declaration

Ich beanspruche hiermit ausländische Prioritätsvorteile gemäß Title 35, US-Code, § 119 (a)-(d), bzw. § 365(b) aller unten aufgeführten Auslandsanmeldungen für Patente oder Erfinderurkunden, oder § 365(a) aller PCT internationalen Anmeldungen, welche wenigstens ein Land ausser den Vereinigten Staaten von Amerika benannten, und habe nachstehend durch ankreuzen sämtliche Auslands- anmeldungen für Patente bzw. Erfinderurkunden oder PCT internationale Anmeldungen angegeben, deren Anmeldung dem der Anmeldung, für welche Priorität beansprucht wird, vorangeht.

I hereby claim foreign priority under Title 35, United States Code, § 119(a)-(d) or § 365(b) of any foreign application(s) for patent or inventor's certificate, or § 365(a) of any PCT International application which designated at least one country other than the United States, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or PCT International application having a filing date before that of the application on which priority is claimed.

Prior Foreign Applications (Frühere ausländische Anmeldungen) (Number) (Nummer)	(Country) (Land)	(Day/Month/Year Filed) (Tag/Monat/Jahr der Anmeldung)	Priority Not Claimed Priorität nicht beansprucht
198 02 524.6	Germany	26 January 1998	☐
			☐

Ich beanspruche hiermit Prioritätsvorteile unter Title 35, US-Code, § 119(e) aller US-Hilfsanmeldungen wie unten aufgezählt.

I hereby claim the benefit under Title 35, United States Code, § 119(e) of any United States provisional application(s) listed below.

(Application No.) (Aktenzeichen)	(Filing Date) (Anmeldetag)

Ich beanspruche hiermit die mir unter Title 35, US-Code, § 120 zustehenden Vorteile aller unten aufgeführten US-Patentanmeldungen bzw. § 365(c) aller PCT internationalen Anmeldungen, welche die Vereinigten Staaten von Amerika benannten, und erkenne, insofern der Gegenstand eines jeden früheren Anspruchs dieser Patentanmeldung nicht in einer US-Patentanmeldung, bzw. PCT internationalen Anmeldung in in einer gemäß dem ersten Absatz von Title 35, US-Code, § 112 vorgeschriebenen Art und Weise offenbart wurde, meine Pflicht zur Offenbarung jeglicher Informationen an, die zur Prüfung der Patentfähigkeit in Einklang mit Title 37, Code of Federal Regulations, § 1.56 von Belang sind und die im Zeitraum zwischen dem Anmeldetag der früheren Patentanmeldung und dem nationalen oder im Rahmen des Vertrags über die Zusammenarbeit auf dem Gebiet des Patentwesen (PCT) gültigen internationalen Anmeldetags bekannt geworden sind.

I hereby claim the benefit under Title 35, United States Code, § 120 of any United States application(s), or § 365(c) of any PCT International application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of Title 35, United States Code, § 112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, § 1.56 which became available between the filing date of the prior application and the national or PCT International filing date of this application.

(Application No.) (Aktenzeichen)	(Filing Date) (Anmeldetag)	(Status) (patented, pending, abandoned) (Status) (patentiert, schwebend, aufgegeben)
PCT/EP99/00373	21 January 1999	Published

Ich erkläre hiermit, daß alle in der vorliegenden Erklärung von mir gemachten Angaben nach bestem Wissen und Gewissen der Wahrheit entsprechen, und ferner daß ich diese eidesstattliche Erklärung in Kenntnis dessen ablege, daß wissentlich und vorsätzlich falsche Angaben oder dergleichen gemäß § 1001, Title 18 des US-Code strafbar sind und mit Geldstrafe und/oder Gefängnis bestraft werden können und daß derartige wissentlich und vorsätzlich falsche Angaben die Rechtswirksamkeit der vorliegenden Patentanmeldung oder eines aufgrund deren erteilten Patentes gefährden können.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

PTO/SB/103 (8-96)
Approved for use through 9/30/98. OMB 0651-0032
Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE

German Language Declaration

VERTRETUNGSVOLMACHT: Als benannter Erfinder beauftrage ich hiermit den (die) nachstehend aufgeführten Patentanwalt (Patentanwälte) und/oder Vertreter mit der Verfolgung der vorliegenden Patentanmeldung sowie mit der Abwicklung aller damit verbundenen Angelegenheiten vor dem US-Patent- und Markenamt: *(Name(n) und Registrationsnummer(n) auflisten)*

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith: *(list name and registration number)*
John F. Hoffman, Regis. No. 26,280; Anthony Niewyk, Regis. No. 24,871; Kevin R. Erdman, Regis. No. 33,687; Michael D. Smith, Regis. No. 40,181; Michael S. Gzybowski, Regis. No. 32,816; Michael D. Schwartz, Regis No. 44,326; Scott M. Lohnes, Regis. No. 45,451; Steven M. Hanley, Regis. No. P-46,756; and Adam F. Cox, Regis No. P-46,644.

Postanschrift:

Send Correspondence to:
John F. Hoffman, BAKER & DANIELS,
111 East Wayne Street, Suite 800, Fort Wayne, IN 46802

Telefonische Auskünfte: *(Name und Telefonnummer)*

Direct Telephone Calls to: *(name and telephone number)*
John F. Hoffman, (219) 424-8000

Vor- und Zuname des einzigen oder ersten Erfinders	Full name of sole or first inventor Harald Hoffeld
Unterschrift des Erfinders Datum	Inventor's signature Date
Wohnsitz	Residence Crailsheim, Germany
Staatsangehörigkeit	Citizenship German
Postanschrift	Post Office Address Brunnenstrasse 41
	D-74564 Crailsheim, Germany
Vor- und Zuname des zweiten Miterfinders (falls zutreffend)	Full name of second joint inventor, if any Gunther Schuttler
Unterschrift des zweiten Erfinders Datum	Second Inventor's signature Date
Wohnsitz	Residence Wallhausen-Michelbach, Germany
Staatsangehörigkeit	Citizenship German
Postanschrift	Post Office Address Judengasse 10
	D-74599 Wallhausen-Michelbach, Germany

(Im Falle dritter und weiterer Miterfinder sind die entsprechenden Informationen und Unterschriften hinzuzufügen.)

(Supply similar information and signature for third and subsequent joint inventors.)

PTO/SB/103 (8-96)
Approved for use through 9/30/98. OMB 0651-0032
Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

Declaration and Power of Attorney for Patent Application
Erklärung für Patentanmeldungen mit Vollmacht

German Language Declaration

Als nachstehend benannter Erfinder erkläre ich hiermit an Eides Statt:

daß mein Wohnsitz, meine Postanschrift und meine Staatsangehörigkeit den im nachstehenden nach meinem Namen aufgeführten Angaben entsprechen, daß ich nach bestem Wissen der ursprüngliche, erste und alleinige Erfinder (falls nachstehend nur ein Name angegeben ist) oder ein ursprünglicher, erster und Miterfinder (falls nachstehend mehrere Namen aufgeführt sind) des Gegenstandes bin, für den dieser Antrag gestellt wird und für den ein Patent für die Erfindung mit folgendem Titel beantragt wird:

_____

_____

deren Beschreibung hier beigefügt ist, es sei denn (in diesem Falle Zutreffendes bitte ankreuzen), diese Erfindung

☐ wurde angemeldet am _____
unter der US-Anmeldenummer oder unter der Internationalen Anmeldenummer im Rahmen des Vertrags über die Zusammenarbeit auf dem Gebiet des Patentwesens (PCT)
_____ und am
_____ abgeändert (falls zutreffend).

Ich bestätige hiermit, daß ich den Inhalt der oben angegebenen Patentanmeldung, einschließlich der Ansprüche, die eventuell durch einen oben erwähnten Zusatzantrag abgeändert wurde, durchgesehen und verstanden habe.

Ich erkenne meine Pflicht zur Offenbarung jeglicher Informationen an, die zur Prüfung der Patentfähigkeit in Einklang mit Titel 37, Code of Federal Regulations, § 1.56 von Belang sind.

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

HYDRODYNAMIC COUPLING

_____

the specification of which is attached hereto unless the following box is checked:

☒ was filed on January 21, 1999
as United States Application Number or PCT International Application Number
PCT/EP99/00373 and was amended on
_____ (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, § 1.56.

PTO/SB/103 (8-98)
Approved for use through 8/30/98. OMB 0651-0032
Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE

German Language Declaration

VERTRETUNGSVOLMACHT: Als benannter Erfinder beauftrage ich hiermit den (die) nachstehend aufgeführten Patentanwalt (Patentanwälte) und/oder Vertreter mit der Verfolgung der vorliegenden Patentanmeldung sowie mit der Abwicklung aller damit verbundenen Angelegenheiten vor dem US-Patent- und Markenamt: *(Name(n) und Registrationsnummer(n) auflisten)*

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith: *(list name and registration number)*

John F. Hoffman, Regis. No. 26,280; Anthony Niewyk, Regis. No. 24,971; Kevin R. Erdman, Regis. No. 33,687; Michael D. Smith, Regis. No. 40,181; Michael S. Gzybowski, Regis. No. 32,816; Michael D. Schwartz, Regis No. 44,326; Steven F. Hanley, Regis. No. P-46,756; and Adam F. Cox, Regis No. P-46,644.

Postanschrift:

Send Correspondence to:
John F. Hoffman, BAKER & DANIELS,
111 East Wayne Street, Suite 800, Fort Wayne, IN 46802

Telefonische Auskünfte: *(Name und Telefonnummer)*

Direct Telephone Calls to: *(name and telephone number)*
John F. Hoffman, (219) 424-8000

Vor- und Zuname des einzigen oder ersten Erfinders	Full name of sole or first inventor: Harald Hoffeld
Unterschrift des Erfinders Datum	Inventor's signature Date 00-09-14
Wohnsitz	Residence: Crailsheim, Germany DEX
Staatsangehörigkeit	Citizenship: German
Postanschrift	Post Office Address: Brunnenstrasse 41
	D-74564 Crailsheim, Germany
Vor- und Zuname des zweiten Miterfinders (falls zutreffend)	Full name of second joint inventor, if any: Günther Schübler
Unterschrift des zweiten Erfinders Datum 2.10	Second Inventor's signature Date 2000-08-23
Wohnsitz	Residence: Wallhausen-Michelbach, Germany DEX
Staatsangehörigkeit	Citizenship: German
Postanschrift	Post Office Address: Judengasse 22
	D-75499 Wallhausen-Michelbach, Germany

(Im Falle dritter und weiterer Miterfinder sind die entsprechenden Informationen und Unterschriften hinzuzufügen.)

(Supply similar information and signature for third and subsequent joint inventors.)